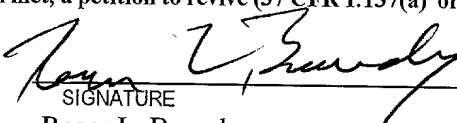


U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER <b>SATO=22</b>
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) <b>09/936289</b>
INTERNATIONAL APPLICATION NO. <b>PCT/JP00/01402</b>	INTERNATIONAL FILING DATE <b>08 March 2000</b>	PRIORITY CLAIMED <b>12 March 1999</b>
TITLE OF INVENTION <b>MATERIAL FOR SHADOW MASK, METHOD FOR PRODUCTION THEREOF, SHADOW MASK...</b>		
APPLICANT(S) FOR DO/EO/US <b>Taizo SATO et al.</b>		
<p>Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:</p> <ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</li> <li><input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</li> <li><input checked="" type="checkbox"/> The US has been elected in a Demand by the expiration of 19 months from the priority date (PCT Article 31).</li> <li><input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))             <ol style="list-style-type: none"> <li><input type="checkbox"/> is attached hereto (required only if not transmitted by the International Bureau)</li> <li><input checked="" type="checkbox"/> has been communicated by the International Bureau</li> <li><input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</li> </ol> </li> <li><input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).</li> <li><input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))             <ol style="list-style-type: none"> <li><input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</li> <li><input type="checkbox"/> have been communicated by the International Bureau.</li> <li><input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired</li> <li><input checked="" type="checkbox"/> have not been made and will not be made.</li> </ol> </li> <li><input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3))</li> <li><input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</li> <li><input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</li> </ol> <p><b>Items 11. to 16. below concern document(s) or information included:</b></p> <ol style="list-style-type: none"> <li><input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98</li> <li><input type="checkbox"/> An Assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</li> <li><input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment. <input checked="" type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</li> <li><input type="checkbox"/> A substitute specification.</li> <li><input type="checkbox"/> A change of power of attorney and/or address letter.</li> <li><input checked="" type="checkbox"/> Other items or information             <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Courtesy copy of the first page of the International Publication (WO 00/55383).</li> <li><input checked="" type="checkbox"/> Courtesy copy of the International Preliminary Examination Report (In Japanese). There were no annexes.</li> <li><input checked="" type="checkbox"/> Formal drawings, 1 sheet, Figures 1-1</li> <li><input checked="" type="checkbox"/> Courtesy Copy of the International Search Report.</li> <li><input checked="" type="checkbox"/> Application Data Sheet</li> <li><input checked="" type="checkbox"/> The application is (or will be) assigned to TOYO KOHAN Co. Ltd., whose address is 2-12, Yonbancho, Chiyoda-ku, Tokyo 102-8447, Japan.</li> </ul> </li> </ol>		

U.S. APPLICATION NO (If known, see 37 CFR 1.5)		International Application No	Attorney's Docket No																																																		
09/936289		PCT/JP00/01402	SATO=22																																																		
17. [xx] The following fees are submitted: <b>BASIC NATIONAL FEE (37 CFR 1.492 (a)(1) –(5):</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO.....\$1000.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO.....\$860.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO. ....\$710.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4).....\$690.00  International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4).....\$100.00  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b> Surcharge of \$130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)). <table border="1"><thead><tr><th>Claims as Originally Presented</th><th>Number Filed</th><th>Number Extra</th><th>Rate</th></tr></thead><tbody><tr><td>Total Claims</td><td>5 - 20</td><td></td><td>X \$18.00</td></tr><tr><td>Independent Claims</td><td>1 - 3</td><td></td><td>X \$80.00</td></tr><tr><td colspan="3">Multiple Dependent Claims (if applicable)</td><td>+\$270.00</td></tr><tr><td colspan="3"><b>TOTAL OF ABOVE CALCULATIONS =</b></td><td>\$ 860.00</td></tr></tbody></table> <table border="1"><thead><tr><th>Claims After Post Filing Prel. Amend</th><th>Number Filed</th><th>Number Extra</th><th>Rate</th></tr></thead><tbody><tr><td>Total Claims</td><td>8 - 20</td><td></td><td>X \$18 00</td></tr><tr><td>Independent Claims</td><td>1 - 3</td><td></td><td>X \$78.00</td></tr><tr><td colspan="3"><b>TOTAL OF ABOVE CALCULATIONS =</b></td><td>\$ 860.00</td></tr></tbody></table> <table border="1"><thead><tr><th>Reduction of 1/2 for filing by small entity, if applicable. Applicant claims small entity status. See 37 CFR 1.27</th></tr></thead><tbody><tr><td><b>SUBTOTAL =</b></td><td>\$ 860.00</td></tr></tbody></table> <table border="1"><thead><tr><th>Processing fee of \$130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).</th></tr></thead><tbody><tr><td><b>TOTAL NATIONAL FEE =</b></td><td>\$ 860.00</td></tr></tbody></table> <table border="1"><thead><tr><th>Fee for recording the enclosed assignment (37 CFR 1.21(h)) The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3 31). \$40.00 per property +</th></tr></thead><tbody><tr><td><b>TOTAL FEES ENCLOSED =</b></td><td>\$ 860.00</td></tr></tbody></table> <table border="1"><thead><tr><th>Amount to be:</th><th>\$</th></tr></thead><tbody><tr><td>refunded</td><td></td></tr><tr><td>charged</td><td></td></tr></tbody></table> <p>a. [ ] A check in the amount of \$ _____ to cover the above fees is enclosed. b. [X] Credit Card Payment Form (PTO-2038), authorizing payment in the amount of \$ 860.00, is attached. c. [ ] Please charge my Deposit Account No. 02-4035 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. d. [XX] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No 02-4035. A duplicate copy of this sheet is enclosed.</p> <p><b>NOTE:</b> Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</p> <p>SEND ALL CORRESPONDENCE TO.</p> <p><b>BROWDY AND NEIMARK, P.L.L.C.</b> 624 NINTH STREET, N.W., SUITE 300 WASHINGTON, D.C. 20001 TEL: (202) 628-5197 FAX: (202) 737-3528 Date of this submission September 12, 2001</p> <p> SIGNATURE Roger L. Browdy NAME 25.618 REGISTRATION NUMBER</p>			Claims as Originally Presented	Number Filed	Number Extra	Rate	Total Claims	5 - 20		X \$18.00	Independent Claims	1 - 3		X \$80.00	Multiple Dependent Claims (if applicable)			+\$270.00	<b>TOTAL OF ABOVE CALCULATIONS =</b>			\$ 860.00	Claims After Post Filing Prel. Amend	Number Filed	Number Extra	Rate	Total Claims	8 - 20		X \$18 00	Independent Claims	1 - 3		X \$78.00	<b>TOTAL OF ABOVE CALCULATIONS =</b>			\$ 860.00	Reduction of 1/2 for filing by small entity, if applicable. Applicant claims small entity status. 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09/936289

J003 Rec'd PCT/JP00 12 SEP 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ATTY.'S DOCKET: SATO=22

In re Application of:	)	Art Unit:
Taizo SATO et al.	)	
	)	Examiner:
	)	
I.A. No.: PCT/JP00/01402	)	Washington, D.C.
	)	
Filed: March 8, 2000	)	September 12, 2001
	)	
For: MATERIAL FOR SHADOW MASK..	)	

PRELIMINARY AMENDMENT

Honorable Commissioner for Patents and Trademarks  
Washington, D.C. 20231

Sir:

Contemporaneous with the filing of this case and prior to  
calculation of the filing fee, kindly amend as follows:

IN THE SPECIFICATION

After the title please insert the following paragraph:

REFERENCE TO RELATED APPLICATIONS

--The present application is the national stage under 35  
U.S.C. §371 of international application PCT/JP00/01402, filed March  
8, 2000 which designated the United States, and which application  
was not published in the English language.--

IN THE CLAIMS

Please amend claim 5 as follows:

5. (Amended) Shadow mask made of the material as claimed in  
claim 1.

09/936289-52231550

In re of: Taizo SATO et al. (SATO=22)

Please cancel claim 6.

REMARKS

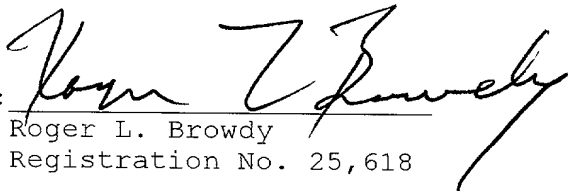
Claims 1-5 presently appear in this case. The above amendment to the specification is being made to insert reference to the PCT application of which the present case is a U.S. national stage. The above amendments to the claims are being made in order to cancel claim 6 and to eliminate any properly multiply dependent claims, for the purpose of reducing the filing fee. Please enter this amendment prior to calculation of the filing fee in this case.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with Markings to Show Changes Made."

Favorable consideration and allowance are earnestly solicited.

Respectfully submitted,  
BROWDY AND NEIMARK, P.L.L.C.  
Attorneys for Applicant

By:

  
Roger L. Browdy  
Registration No. 25,618

RLB:wrđ

Telephone No.: (202) 628-5197

Facsimile No.: (202) 737-3528

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Claim 5 has been amended as follows:

5. (Amended) Shadow mask made of the material as claimed in  
claim 1 ~~or claim 2~~.

Claim 6 has been canceled.

0936289-094300

09/936289

JCO3 Rec'd PST/TO 12 SEP 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

ATTY.'S DOCKET: SATO=22

In re Application of:	)	Art Unit:
Taizo SATO et al.	)	
	)	Examiner:
	)	
I.A. No.: PCT/JP00/01402	)	Washington, D.C.
	)	
Filed: March 8, 2000	)	September 12, 2001
	)	
For: MATERIAL FOR SHADOW MASK..	)	

SUPPLEMENTAL PRELIMINARY AMENDMENT

Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to examination upon the merits, kindly amend as follows:

IN THE CLAIMS

Please add the following claims:

--7. Shadow mask made of the material as claimed in claim 2.

8. A picture tube with said shadow mask as claimed in claim 5.

9. A picture tube with said shadow mask as claimed in claim 7.--

REMARKS

Claims 1-5 and 7-9 presently appear in this case.  
The above amendments to the claims are being made in order to,

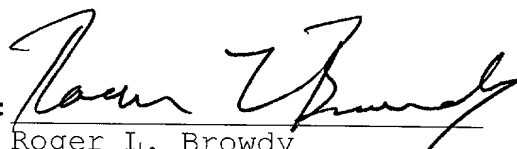
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add new claims and to restore at least partly the varying scope of claims, which was eliminated by the elimination of multiple dependencies in the claims.

Favorable consideration is earnestly solicited.

Respectfully submitted,

BROWDY AND NEIMARK, P.L.L.C.  
Attorneys for Applicant

By:   
Roger L. Browdy  
Registration No. 25,618

RLB:wrđ  
Telephone No.: (202) 628-5197  
Facsimile No.: (202) 737-3528  
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09/9<sup>①</sup>36289  
1644PCT-US

## WITH THE SHADOW MASK

The cold rolled steel sheet manufactured by such a method is installed in a picture tube after performed by photo etching, annealing, pressing and baking. Unless carbon originally contained in the cold rolled steel sheet is decarbonized sufficiently during



the above described steps, improper etching and improper press forming would be induced. Therefore, a content ratio of decarbonized and annealed carbon should be equal or less than 0.0015 wt%, preferably equal or less than 0.0008 wt%.

Regarding a cold rolled steel sheet used for a shadow mask manufactured by a method comprising the above described etching and press forming steps, it has been required that etching performance and press forming performance should be more stable than the conventional ones since a picture tube is required to provide high picture quality and improve its fine degree.

Japanese Patent Laid-open Publication No. Shou 56-139624, No. Hei 2-61029 and No. Hei 8-269627 discloses a method to resolve such a problem, respectively. In the above prior art, although steel components and annealing condition are described, these are not sufficient to provide stable etching performance and press forming performance in order to satisfy recent requirements with respect to the shadow mask material such as high picture quality and its fine improvement.

A purpose of the invention is to resolve the above described drawbacks in the conventional art and to provide shadow mask material with characteristic uniformly etched in a coil and press forming characteristic installed in a picture tube.

#### DISCLOSURE OF THE INVENTION

Shadow mask material according to the present invention is

characterized of comprising nitrogen equal or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities.

Shadow mask material according to the present invention is characterized of comprising carbon equal or less than 0.0008 wt%, silicon equal or less than 0.03 wt%, manganese from 0.1 to 0.5 wt%, phosphorus equal or less than 0.02 wt%, sulfur equal or less than 0.02 wt%, aluminum from 0.01 to 0.07 wt%, nitrogen equal or less than 0.0030 wt% and boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities.

A method for manufacturing shadow mask material made of a steel sheet according to the present invention is characterized of comprising nitrogen equal or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities, wherein a hot rolling furnish is higher than a point  $Ar_3$ , the steel sheet is hot rolled at a coiling temperature from 540 to 680 °C and cold rolled after pickling and then the steel sheet is annealed in a continuous annealing step so as to control a content ratio of remained carbon equal or less than 0.0008 wt%.

A method for manufacturing shadow mask material made of a steel sheet according to the present invention is characterized of comprising carbon equal or less than 0.0008 wt%, silicon equal or less than 0.03 wt%, manganese from 0.1 to 0.5 wt%, phosphorus equal

or less than 0.02 wt%, sulfur equal or less than 0.02 wt%, aluminum from 0.01 to 0.07 wt%, nitrogen equal or less than 0.0030 wt% and boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities, wherein a hot rolling furnish is higher than a point Ar<sub>3</sub>, said steel sheet is hot rolled at a coiling temperature from 540 to 680 °C and cold rolled after pickling and then said steel sheet is annealed in a continuous annealing step so as to control a content ratio of remained carbon equal or less than 0.0008 wt%.

A shadow mask according to the present invention is characterized of comprising the above described shadow mask material.

A picture tube according to the present invention is characterized of comprising the above described shadow mask.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a graph for showing a relation of an etching characteristic and an inequality of amounts of boron and nitrogen.

#### BEST MODE FOR CARRYING OUT THE INVENTION

Regarding chemical composition of the hot rolled steel sheet, the following chemical composition are preferable. That is, a steel sheet comprises nitrogen equal or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residua including iron and unavoidable impurity.

$N: \leq 0.0030 \text{ wt\%}$

Nitrogen in steel makes nitride with aluminum. On the other hand, aging effect of the steel is reduced by decreasing solid soluble nitrogen. Therefore, it is preferable that amount of nitrogen is as less as possible. In order to maintain the press forming characteristic as shadow mask material, it is necessary that the amount of nitrogen is remarkably low and it is preferable that the upper limit is 0.0030 wt%, more preferable 0.0020 wt%.

Boron:  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$

Boron in steel uniforms crystal grain in a thin steel sheet so that excellent etching characteristic can be obtained as shadow mask material. Particularly, boron makes big effect with respect to an extremely thin shadow mask having a thickness of 0.1 to 0.2 mm which has been used recently.

It is preferable that boron is added into steel since boron is an effective element so as to fix solid soluble nitrogen. On the other hand, if an amount of boron is too much, crystal grains are extremely fine and its magnetic characteristic is influenced banefully. Therefore, it is preferable that an amount of boron is within a predetermined range.

In the present invention, it is preferable that the content of boron is satisfied with the above inequality. If the content ratios of nitrogen and boron are within the above described ranges, respectively, an excellent etching characteristic can be obtained as shown in Fig. 1. Further, in the present invention, it is preferable that the following chemical composition of a hot rolled

steel sheet are controlled as a steel sheet having a thickness of 0.08 to 0.2 mm suitable for an extremely thin shadow mask material.

That is, an content of carbon is equal or less than 0.0030 wt%, a content of silicone is equal or less than 0.03 wt%, a content of manganese is from 0.1 to 0.5 wt%, a content ratio of phosphorus is equal or less than 0.02 wt%, a content ratio of surfer is equal or less than 0.02 wt% and a content ratio of aluminum is from 0.01 to 0.07 wt%. The reason of the above ratios will be described hereinafter.

Carbon:  $\leq 0.0030$  wt%

An amount of carbon in hot rolled steel sheet is much influenced to a continuous annealing step for decarbonizing. If the content ratio of carbon exceeds 0.0030 wt%, carbon can not be decarbonized sufficiently in the continuous annealing step. To provide shadow mask material of which a content ratio of carbon is equal or less than 0.0008 wt%, an annealing temperature has to be increased and an annealing time has to be extended. Therefore, a manufacturing cost would become higher and a productivity would become lower. It is preferable that the upper limit is 0.0030 wt%, more preferably 0.0020 wt%.

Silicon:  $\leq 0.03$  wt%

Silicon contained in shadow mask material is an element to prevent shadow mask material from blacking in a blacking treatment for manufacturing a picture tube. Although the content ratio is preferable as less as possible, silicone is an unavoidable element

as an aluminum killed steel. It is preferable that the upper limit is 0.03 wt%, more preferably 0.02 wt%.

Manganese: 0.1 to 0.5 wt%

In hot rolled steel, manganese is necessary to prevent silicone as impurity from becoming red thermal brittle in a hot rolling step. In the case of an extreme thin shadow mask material according to the present invention, the material is apt to be cracked in a cold rolling step. Therefore, it is preferable to add a predetermined amount of manganese. A content ratio of manganese is preferably equal or more than 0.1 wt%, more preferably equal or more than 0.2 wt%, and further more preferably equal or more than 0.25 wt%.

On the other hand, the upper limit of the content ratio of manganese is preferably 0.5 wt%, more preferably 0.4 wt% and further more preferably 0.35 wt%, since the forming characteristic is deteriorated if the content ratio exceeds 0.6 wt%.

Phosphorous:  $\leq$  0.02 wt%

In the shadow mask material, phosphorous reduce the size of crystal grains so that the magnetic characteristic becomes worse. It is preferable that the content ratio of phosphorous is as less as possible. Particularly, in such an extreme thin shadow mask material according to the present invention, phosphorus is baneful influenced seriously, the content ratio of phosphorus is preferably equal or less than 0.02 wt%.

Sulfur:  $\leq$  0.02 wt%

In hot rolled steel, sulfur is an unavoidable element and impurity so as to make the steel red thermal brittle. It is earnestly preferable that a content ratio of sulfur is as less as possible. Particularly, in such a an extreme thin shadow mask material according to the present invention, the material is apt to be cracked in a cold rolling step. Therefore, it is preferable to avoid sulfur as much as possible. To avoid the above phenomenon, the upper limit is preferably 0.02 wt%, more preferably 0.015 wt% and further more preferably 0.01 wt%.

Aluminum: 0.01 to 0.07 wt%

In a step of manufacturing hot rolled steel, aluminum is added to melt steel as deoxidizer and then removed as slag. Unless the added amount of aluminum is sufficient, a certain deoxidization effect can not be obtained. It is preferable that aluminum is added affirmatively so as to form aluminum nitride in a hot rolling step and an annealing step and to prevent solid soluble nitrogen from aging by fixing nitrogen. Particularly, in the case of the extreme thin shadow mask material according to the present invention, the material is apt to be cracked caused by including impurity such as oxide in a cold rolling step. Therefore, it is necessary to add aluminum as much as possible. The lower limit is preferably 0.01 wt%, more preferably 0.02 wt%.

On the other hand, even if the content ratio of aluminum exceeds 0.07 wt%, the above effect can not be improved so much. Such redundant aluminum induces to increase recrystallization

temperature and to increase the amounts of the inclusion. The upper limit is preferably 0.07 wt%, more preferably 0.05 wt%, further more preferably 0.04 wt%.

Residue: Iron and avoidable elements without influencing the etching characteristic and the press formation characteristic are not restricted.

A method for manufacturing an extreme thin shadow mask material according to the present invention will be described. Although a slab heating temperature and a hot rolling condition are not so restricted in the present invention, the slab heating temperature is preferably higher than 1100 °C so as to keep a hot rolling temperature since a hot rolling property becomes worse if the slab heating temperature is less than 1100 °C. On the other hand, if the slab heating temperature is too high, nitride is proceeded to be dissolved and become solid soluble again. The slab heating temperature is preferable less than 1220 °C.

If the hot rolling furnish temperature is equal or less than  $A_{r3}$ , crystal grains are mixed and become big in a crystal structure of a hot rolled steel sheet so that the etching characteristic and the press forming characteristic are deteriorated. The hot rolling furnish temperature is preferably higher than  $A_{r3}$ .

A lower limit of a coiling temperature is preferably 540 °C aspect from a point of quality stability of a hot rolled steel sheet along a width direction and a longitudinal direction of a coil in a hot rolling step. On the other hand, if the coiling temperature



exceeds 680 °C, descaling characteristic is deteriorated. The coiling temperature is preferably from 540 °C to 680 °C.

(Pickling, first cold rolling step)

Pickling and first cold rolling step may be normal conditions. In order to decarbonize and anneal an extreme thin shadow mask material according to the present invention effectively, a thickness of a steel sheet after the first cold rolling is preferably equal or less than 0.6 mm and more preferably equal or less than 0.5 mm.

(Continuous annealing step)

A continuous annealing step is an important step in the present invention. The continuous annealing step is preferable operated in a condition wherein a sheet temperature is equal or more than 750 °C, a soaking period is equal or more than 60 seconds, a content ratio of hydrogen is from 0 to 75 % and the residue is nitrogen gas in the annealing atmosphere and a dew point is from -30 °C to 70 °C.

(Annealing temperature)

The annealing temperature is influenced to a decarbonization effect and the etching characteristic. If the annealing temperature is less than 750 °C, it spends long time to decarbonize. In addition to reduce the productivity, a structure of recrystallization after annealing becomes uneven so that a uniform etching characteristic can not be obtained. Accordingly, the annealing temperature is preferably equal or higher than 750 °C.

(Annealing time)

Annealing time is preferably equal or more than 60 seconds. If the annealing time is less than 60 seconds, the decarbonization with respect to the extreme thin shadow mask material is insufficient so that a content of carbon can not be reduced to a target level equal or less than 0.0008 %. Although the upper limit is not necessary restricted, the annealing time is preferably equal or less than 120 seconds aspect from a point of the productivity and an avoidance of big grains.

(Hydrogen density and dew point in a continuous annealing atmosphere)

If the content ratio of hydrogen gas in the continuous annealing atmosphere can be maintained equal or less than 70 %, a content ratio of carbon in the extreme thin shadow mask material can be reduced to a level equal or less than 0.0008 %. Even if the content ratio of hydrogen gas exceeds 70 %, the decarbonization time is not so changed and the manufacturing cost is increased. The upper limit of the content ratio of hydrogen gas is preferably 70 %. In the case that the dew point is in a range from  $-30^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ , the content ratio of carbon in the extreme thin shadow mask material is equal or less than 0.0008 %.

(Secondary cold rolling after annealing)

Reduction ratio of secondary cold rolling after annealing is preferably from 41 % to 90 % so as to provide necessary strength for an extreme thin shadow mask material. If the reduction ratio is

equal or less than 40 %, necessary strength can not be obtained. If the rolling ratio is equal or more than 91%, number of rolling steps is increased and the productivity is reduced. Therefore, the upper limit is preferably 90 %. Through the secondary cold rolling, the furnish thickness of the extreme thin shadow mask material becomes from 0.1 to 0.2 mm.

#### EXAMPLES

Examples according to the present invention will be described as below. Steel sheet having chemical composition as shown in Table 1 is hot rolled so as to form a hot rolled steel sheet having a thickness of 2.3 mm. After pickling, the steel sheet is cold rolled so as to form a cold rolled steel sheet having a thickness of 0.3 mm. During a continuous annealing step, decarbonization annealing is operated under various conditions. Table 2 shows annealing condition and a content ratio of carbon after annealing with respect to each example. Further, the extreme thin shadow mask material having a thickness of 0.1 mm is formed by the cold rolling.

[Table 1]

Steel sheet no.	Chemical composition (wt%)								
	C	Si	Mn	P	S	Al	N	B	Fe
1	0.0021	0.03	0.36	0.017	0.017	0.041	0.0017	0.0021	Residue
2	0.0021	0.02	0.22	0.017	0.018	0.045	0.0023	0.0030	Residue
3	0.0024	0.02	0.30	0.010	0.016	0.048	0.0021	0.0021	Residue
4	0.0018	0.03	0.33	0.013	0.012	0.051	0.0010	0.0013	residue

[Table 2]

Example or comparative example	Steel sheet no.	Annealing temperature (°C)	Annealing time (second)	Content ratio of hydrogen gas (%)	Wet point (°C)	Carbon content ratio in steel after annealing
Example 1	1	760	60	5	20	0.0007
Example 2	1	775	60	5	20	0.0006
Example 3	1	800	60	50	-30	0.0005
Example 4	2	775	60	5	20	0.0006
Example 5	3	775	60	5	20	0.0006
Example 6	4	775	60	5	20	0.0006
Comparative example 1	1	725	80	5	20	0.0011
Comparative example 2	1	760	30	5	20	0.0014
Comparative example 3	1	760	60	5	-40	0.0010

In the next, a shadow mask used with the above described material will be described. Water soluble casein-resist is coated on the both surfaces of the shadow mask material. Then, dried resist coated on the both surfaces is patterned by a pair of dry plates on which ins and outs patterns are drawn. After patterning, an exposure treatment, a film hardening treatment and a baking treatment are operated. Then, ferric chloride solution (solution temperature 60 °C, specific gravity 48° Be) is sprayed on the both patterned resist surfaces as etching solution so as to etch the shadow mask material. After etching, the steel sheet is cleaned with alkaline solution so as to peel the resist. In the last, the

shadow mask is manufactured by cleaning and drying. The result of the evaluation of the etching characteristic is shown in Fig. 1. In Fig. 1, a vertical axis indicates etching characteristic and a horizontal axis indicates a relation between amounts of boron and nitrogen. Judging from Fig. 1, an excellent etching characteristic can be obtained while the relation between the amount of boron and nitrogen satisfies the inequality of  $5 \text{ ppm} \leq B-11/14 \times N \leq 30 \text{ ppm}$ .

In Fig. 1, the etching characteristic is evaluated as three ranked standard in accordance with a shape of etched hole.

Evaluation point 3 --- good: profile of slot hole in view from an etching surface does not have any practical problem.

Evaluation point 2 --- intermediate: profile of slot hole in view from an etching surface is a little uneven.

Evaluation point 1 --- poor: profile of slot hole in view from an etching surface is deformed.

In the next, a condition in which the shadow mask according to the present invention is attached to a frame will be described. The shadow mask according to the present invention is fixed on the frame while tensile force is loaded. Although various methods for fixing a shadow mask on a frame can be considered, a welding method is the best known method. Initially, while a center portion of each upper and lower frame bars of a frame is forcibly flexed toward an inward direction, a shadow mask is fixed on the frame. Then, flexed upper and lower frame portions are returned to original positions, respectively (releasing forcibly force) so that tensile force can

be applied to the shadow mask along an upper-lower direction.

When the shadow mask is fixed on the frame as described above, it is preferable that tensile force along a right-left direction of which amount is less than the tensile force along the upper-lower direction is loaded. In a picture tube according to the present invention, it is preferable that strong tensile force is applied along the upper-lower direction. In addition to the load in the upper-lower direction, the tensile force is loaded in the right-left direction. Thus the shadow mask can prevent from crinkling by applying the tensile force along the upper-lower direction. However, if the large amount of tensile force were applied on the shadow mask along the right-left direction, slot holes formed on the shadow mask would be deformed.

#### POSSIBILITY OF USE IN THE INVENTION

Unless the carbon amount is decarbonized sufficiently, etching becomes uneven in an etching step for manufacturing a shadow mask. Thereby, profile of etched holes does not become uneven and unevenness of the surface become large. Unless the carbon amount is equal or less than 0.0008%, the sufficient etching characteristic can not be obtained. If the carbon content is too much, the shadow mask material becomes hard and a shape freezing characteristic is deteriorated in a press forming step. Therefore, the carbon amount should be lowered.

As shown in Fig. 1, boron can fix nitrogen and prevent

nitrogen from occurring stretcher strain caused by aging solid soluble nitrogen and uniform recrystallized grains. In order to stabilize the etching characteristic, necessary amount of boron is required to add to the material. However, if the added amount of boron is too much, high crystal grains become extremely fine so that the high qualification and the magnetic characteristic are deteriorated.

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## CLAIM (An original English claims)

(8)

1. Shadow mask material comprising nitrogen equal or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B-11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities.

2. Shadow mask material comprising carbon equal or less than 0.0008 wt%, silicon equal or less than 0.03 wt%, manganese from 0.1 to 0.5 wt%, phosphorus equal or less than 0.02 wt%, sulfur equal or less than 0.02 wt%, aluminum from 0.01 to 0.07 wt%, nitrogen equal or less than 0.0030 wt% and boron satisfying an inequality of  $5 \text{ ppm} \leq B-11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities.

3. A method for manufacturing shadow mask material made of a steel sheet characterized of comprising nitrogen equal or less than 0.0030 wt%, boron satisfying an inequality of  $5 \text{ ppm} \leq B-11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities, wherein a hot rolling furnish is higher than a point  $Ar_3$ , said steel sheet is hot rolled at a coiling temperature from 540 to 680 °C and cold rolled after pickling and then said steel sheet is annealed in a continuous annealing step so as to control a content ratio of remained carbon equal or less than 0.0008 wt%.



4. A method for manufacturing shadow mask material made of a steel sheet characterized of comprising carbon equal or less than 0.0008 wt%, silicon equal or less than 0.03 wt%, manganese from 0.1 to 0.5 wt%, phosphorus equal or less than 0.02 wt%, sulfur equal or less than 0.02 wt%, aluminum from 0.01 to 0.07 wt%, nitrogen equal or less than 0.0030 wt% and boron satisfying an inequality of  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$  and the residue including iron and unavoidable impurities, wherein a hot rolling furnish is higher than a point  $Ar_3$ , said steel sheet is hot rolled at a coiling temperature from 540 to 680 °C and cold rolled after pickling and then said steel sheet is annealed in a continuous annealing step so as to control a content ratio of remained carbon equal or less than 0.0008 wt%.

5. Shadow mask made of the material as claimed in claim 1 or claim 2.

6. A picture tube with said shadow mask as claimed in claim 5.

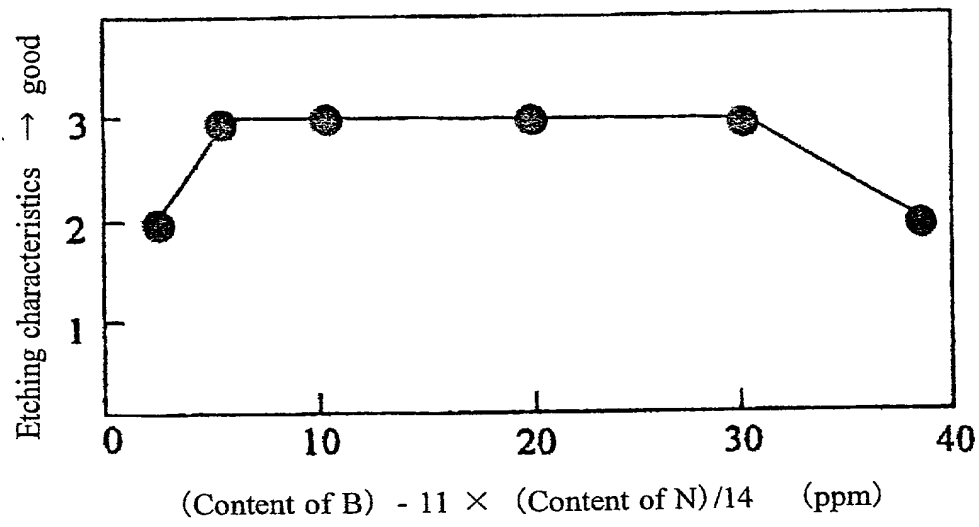
[Name of the document] ABSTRACT

A material for shadow mask having the following composition of components: C  $\leq 0.0008$  wt%, Si  $\leq 0.03$  wt%, Mn: 0.1 to 0.5 wt%, P  $\leq 0.02$  wt%, S  $\leq 0.02$  wt%, Al: 0.01 to 0.07 wt%, N  $\leq 0.0030$  wt%, B: an amount satisfying the formula:  $5 \text{ ppm} \leq B - 11/14 \times N \leq 30 \text{ ppm}$ , balance: Fe and inevitable impurities; a method for producing the material; a shadow mask using the material (cold rolled steel sheet); and an image receiving tube equipped with the shadow mask. The material has excellent etching characteristics, which are uniform within the same coil, and excellent press formability.

09936369.094304

Fig. 1

1/1



## Combined Declaration for Patent Application and Power of Attorney

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; and that I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

MATERIAL FOR SHADOW MASK, METHOD FOR PRODUCTION THEREOF, SHADOW MASK AND IMAGE RECEIVING TUBE

the specification of which (check one)

- [ ] is attached hereto;  
 [ ] was filed in the United States under 35 U.S.C. §111 on \_\_\_\_\_, as  
 U.S. Appl. No. \_\_\_\_\_; or  
 [X] was/will be filed in the U.S. under 35 U.S.C. §371 by entry into the U.S. national stage of an international  
 (PCT) application, PCT/JP00/01402; filed March 8, 2000 entry  
 requested on \_\_\_\_\_; national stage application received U.S. Appl. No. \_\_\_\_\_;  
 §371/§102(e) date \_\_\_\_\_ (\* if known)

and was amended on \_\_\_\_\_ (if applicable).

(include dates of amendments under PCT Art. 19 and 34 if PCT)

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above; and I acknowledge the duty to disclose to the Patent and Trademark Office (PTO) all information known by me to be material to patentability as defined in 37 C.F.R. §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §§ 119 (a)-(d) and 365 (b) of any prior foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or under §365(a) of any PCT application which designated at least one country other than the U.S., listed below:

Application No.	Country	Filing Date (MM/DD/YYYY)
11/66542	Japan	March 12, 1999

If I claimed foreign priority above, I hereby identify below any foreign application for patent (including an international (PCT) application designating a country other than the United States) or for an inventor's or plant breeder's certificate, having a filing date before that of the earliest application from which foreign priority is claimed (if left blank, then there are none):

Non-Priority Application No.	Country	Filing Date (MM/DD/YYYY)

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional applications listed below:

Application No.	Filing Date (MM/DD/YYYY)

I hereby claim the benefit under 35 U.S.C. §120 of any prior U.S. non-provisional application(s) or under §365(c) of any prior PCT international application(s) designating the U.S., listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in such U.S. or PCT international application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the PTO all information which is material to patentability as defined in 37 C.F.R. §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application No.	Filing Date (MM/DD/YYYY)	Status (patented, pending, abandoned)

As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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Title MATERIAL FOR SHADOW MASK, METHOD FOR PRODUCTION THEREOF, SHADOW...U.S. Application filed \_\_\_\_\_, Serial No. \_\_\_\_\_  
PCT Application filed March 8, 2000, Serial No. PCT/JP00/01402

The undersigned hereby authorizes the U.S. Attorneys or Agents appointed herein to accept and follow instructions from TOYO KOHAN CO., LTD. as to any action to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. Attorneys or Agents and the undersigned. In the event of a change of the persons from whom instructions may be taken, the U.S. Attorneys or Agents appointed herein will be so notified by the undersigned.

I hereby further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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POST OFFICE ADDRESS			
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